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(54) Title of Invention: Endoscope

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SPECIFICATIONS

1. TITLE OF THE INVENTION

Endoscope

2. SCOPE OF PATENT CLAIM

This endoscope is characterized by a capsule-shaped unit; observation device designed into this unit; method 1 that selectively generates a force of inertia in a different direction from the aforementioned unit; method 2 that generates the force of inertia of method 1 or changes the direction of the force of inertia; method 3 that receives signals controlling method 2; method 4 that telemetrically transmits signals for method 3 or image signals from the aforementioned observation device; and is used by floating the aforementioned unit in low-gravity or

zero-gravity space.

3. DETAILED DESCRIPTION OF THE INVENTION

[Field of Industrial Application]

This invention is an endoscope used in low-gravity or zero gravity space.

[Conventional Technology]

Until now, there have been numerous endoscopes that have been proposed and used to internally inspect body cavities, engines, piping, etc.

However, these conventional endoscopes must all be used on Earth. Due to the affect of gravity, a large amount of force is needed to control the endoscope remotely and to change the line of sight or the direction of movement. Accordingly, these

endoscopes need to be equipped with a power source or operating transmitters with a large driving force. In addition, these conditions complicate configuration and increase the size of the device.

[Problems to be resolved by the Invention]

In recent years, there has been an increase in the opportunities for humans to live in outer space using rockets and space stations. Naturally, it is expected that examinations within live bodies and machines will also become necessary in outer space.

In this case, gravity decreases as the distance away from the earth's gravitational sphere increases, where zero gravity space is soon reached. Although different concepts must be used to operate endoscopes in this environment, endoscopes for use in this environment have yet to be conceptualized.

This invention focuses on the aforementioned problem and strives to provide an endoscope that simplifies examinations, reduces invasiveness, and

can be used for a broad range of examinations in low-gravity or zero gravity space.

[Means and Actions for Solving the Problems]

To solve the aforementioned problems, this invention is an endoscope that is characterized by a capsule-shaped unit; observation device designed into this unit; method 1 that selectively generates a force of inertia in a different direction from the aforementioned unit; method 2 that generates the force of inertia of method 1 or changes the direction of the force of inertia; method 3 that receives signals controlling method 2; method 4 that telemetrically transmits signals for method 3 or image signals from the aforementioned observation device; and is used by floating the aforementioned unit in low-gravity or zero-gravity space.

[Embodiment]

Figures 1 to 3 display Embodiment 1 of this invention.

No. 1 in Figure 1 is the endoscope unit shaped like a capsule where the front and rear ends are spherical and the middle is cylindrical. There are various necessary components that are included within Unit 1, as described below. This endoscope is meant to float independently in low-gravity or zero gravity space.

The Objective Lens 2 is located at the center of the front end of Unit 1 as an observation device. A solid-state image sensor, i.e. CCD 3, is situated within the Objective Lens 2. The CCD Drive Circuit 5 is controlled by a Controller 4 located within CCD 3. The CCD 3 is configured with an observation device that changes the viewed images with the Objective Lens 2 into imaging signals. These signals are transmitted to an External Receiver 7 through an Image Transmitter 6. The signals

received by the External Receiver 7 are then changed to picture signals using a Video Circuit 8 and the viewed images observed by the endoscope are displayed on a Monitor 9.

In addition, LEDs 11 is located at the top and bottom of the Objective Lens 2 as a means for illumination at the front end of Unit 1.

Furthermore, multiple Nozzles 12 are formed on the perimeter of the rear end of Unit 1 directed diagonally behind in isometric intervals and each Nozzle 12 is connected individually to a Tank 14 through a Valve 9. The Tank 14 is filled with compressed air. Each Valve 9 opens and closes upon receiving a signal from the Valve Controller 16 that is operated by a Receiver 15. The Receiver 15 is operated by signals transmitted by the External Transmitter 17.

The telemetric transmission of signals from the aforementioned Image Transmitter 6 to the External Receiver 7 and from the External Transmitter 17 to the Receiver 15 is conducted by wireless or ultrasonic means as much as possible according to the environment. In addition, the power required by the CCD Drive Circuit 5, LED 11, each Valve 9, Receiver 15, Valve Controller 16, etc. is supplied by the Power Source (storage cell) 13.

Furthermore, the aforementioned Tank 14 is located at the center within Unit 1, as displayed in Figure 1. The Image Transmitter 6 and Controller 4 are located in front of the Tank 14 within Unit 1 and the Power Source 13 is located above these two devices. The Receiver 15 is also in the rear of Unit

In response to the signals received by the Receiver 15, the Valve Controller 16 repeatedly opens specific Valves 9 for short burst and compressed air from the Tank 14 is repeatedly released in bursts.

Unit 1 then uses the inertia (propulsion) created from the release of compressed air from the Nozzles 12 in bursts to move. Unit 1 changes direction and moves as it uses inertia to travel, as directed by the bursts from the Nozzles 12. Figure 3 displays the valve drive signal and opened valve (when compressed air is released) and their distance relationship with Unit 1.

As the endoscope changes direction and moves in low-gravity or zero gravity space, this simplifies examinations, reduces invasiveness, and can be used for a broad range of examinations.

Furthermore, multiple length measuring sensors

1.

The following is an explanation regarding the use of the endoscope as configured above. This endoscope is placed within a body cavity of a patient in low-gravity or zero gravity space. Unit 1 will float within the body cavity. The External Transmitter 17 is operated to telemetrically transmit signals to the endoscope's Receiver 15 to change the position of Unit 1 or move it forward.

are located in different directions on the external side of Unit 1 and the device may also monitor its location by incrementally measuring the distance from Unit 1 to the surrounding walls while traveling by inertia. In addition, if there is no change to the data regarding the various distances to the surrounding walls using the length measuring sensors located around Unit 1, the movement of the device is maintained. If change is detected, the direction and the distance of the movement by Unit 1 can be measured and inertia opposite the direction of the movement can be applied.

Figure 4 and 5 display Embodiment 2 of this invention. Piezoelectric Devices 21 that generate ultra sound are located around the rear of Unit 1 and the various parts of the rear end in this embodiment. The generated ultra sound provides the inertia (propulsion) to Unit 1.

A piezoelectric device drive circuit 22 operated by signals received by the Receiver 15 is located within Unit 1 and selectively drives the aforementioned Piezoelectric Devices 21. Embodiment 2 controls the inertia and direction using ultra sound. Other configurations and actions are the same as those listed in the aforementioned Embodiment 1.

Figure 6 and 7 display Embodiment 3 of this invention. Fans 25 are located on the sides of the rear and on the rear end pointing to over three directions. The various Fans 25 are each driven by a Motor 26. In addition, a Motor Drive Circuit 27 is located within Unit 1 to operate the fans by signals received by the Receiver 15.

In this Embodiment, the selective drive of the fan 25 blows out the surrounding fluid to control the propulsion and direction of Unit 1. Other configurations and actions are the same as those listed in the aforementioned Embodiment 1.

The Auxiliary Tank 36 is always supplied with pressurized fluid from the external Pump 37 through the aforementioned Pressurized Tube 33. Similarly, the Electromagnetic Valve 39 selectively opens according to the Valve Controller 40 located within Unit 1. In addition, the Valve Controller 40 operates according to the signals received by the Receiver 15. Other configurations and actions are the same as those listed in the aforementioned embodiment.

This embodiment opens specific Electromagnetic Valves 39 according to the Valve Controller 40 operated by the signals received by the Receiver 15. Pressurized fluid is supplied by the Auxiliary Tank 36 and bursts from the corresponding Nozzles 38. This controls the

Figure 8 and 9 display Embodiment 4 of this invention. In this Embodiment, a Cable 31, created from flexible tubing, extrudes from the rear end of Unit 1 and an Energy Transmission Line 32 and Pressurized Tube 33 is inserted within the Tube 31. The Energy Transmission Line 32 is connected to the Energy Controller 34 within Unit 1 and the External Power Source 35. The Pressurized Tube 33 is connected to the Auxiliary Tank 36 within Unit 1 and a Pump 37. Furthermore, multiple Nozzles 38 is located in different locations and various directions on the external side of Unit 1. For example, vertical Nozzles 38 is located on the exterior of Unit 1 relatively towards the front and multiple Nozzles 38 is located in a diagonally outward direction in isometric intervals on the exterior of Unit 1 relatively towards the rear. Each Nozzle 38 is connected individually to the aforementioned Auxiliary Tank 36 through the various Electromagnetic Valves 39.

propulsion and direction of Unit 1. In addition, the energy of the various components is received from the External Power Source 35 through the Energy Transmission Line 32 and is supplied through the Energy Controller 34. Other configurations and actions are the same as those listed in the aforementioned Embodiment 1.

Propulsion and posture control can be achieved in the endoscope by giving an inertial force using magnet. In other words, inertial force can be obtained by fixing a magnet to the body and suspending in the magnetic field and changing the magnetic field 3 dimensionally.

Figure 10 and 13 show an example of execution of invention number 5. These are related to the micro robots used as self propelled inspection device in the blood vessel. As shown in Figure 10, this device uses multiple capsule parts (41, 42, 43) and connects them in a line. Ultrasonic image pickup device 44, which gets a 2 dimensional front view, is placed at main body 41a in the capsule part 41. Ultrasonic device 45 is placed in capsule part 42 and takes the cross sectional ultrasonic image of blood vessel 46. Further, a telemetry functional part is inserted in the last capsule part 43. A transmission cable 47 is also connected at the last point of capsule part 43.

Also, multiple self propelled arms 48 are attached along the circumference, projecting diagonally from the surface of capsule part 41. As shown in figures 12 and 13, the self propelled arms are 2 directional shape memory alloys and are attached with electrical conducting layers. For

When the current flow is stopped after the movements of the arms, it will spontaneously heat up and return to the previous state in figure 11 (1) F the part 51 is made of one directional shape memory alloy, stop the electrical flow and make it return to the previous state shown in figure 11 (1) by resilient restoration action.

Therefore, in the self propelled inspection device in the blood vessel, if the arms 48 in the capsule part 41 are activated, the arms will kick the walls of the blood vessels 46 and thrush forward the capsule part 41. Further, the Ultrasonic image pickup device 44 will take the 2-dimensional front image and examine. Simultaneously, the Ultrasonic image pickup device 45 in the capsule part 42 will take the cross sectional ultrasonic image of blood vessel 46. The data of the examination will be done

example, the electrical conducting layer 52 is made of nickel, and joins flat part of 52a from one end to another to form a loop. Further, the widths between one terminal and the other are gradually reduced. Both the surfaces of the electrical conducting layer 52 are also coated by insulator 53. The width is bent as shown in figure 11 (1) and attached to the edge of capsule part 41. When the self propelled arms are activated, the current flows to the electrical conducting layer 52. If it is allowed to generate heat by electrical resistance and the front end of the electrical conducting layer 52 is heated at a high temperature, the A part will flex as shown in figure 11 (2) If the heating is continued, the part B will bend as shown in figure 11 (3) This bending of the part A towards B will activate the self propelled arms 48.

by the telemetry function of the capsule area 43. The data can be received through a cable attached to it.

If the arms 48 do not activate, extend the arms diagonally forward so that the ends reach the wall of the blood vessel 46 and support the capsule areas 41, 42 and 43.

As the mechanism of this type of device is simple and can be further made slender, it can be used inside the ducts as well. The mechanism of the self propelled arms 48 is also not limited to the one mentioned above, but can also be a bimetal as shown in figures 14 and 16. In other words, one side of the resinous matter 55 is attached with a looped nickel layer and the nickel layer 56 is covered with electrical conducting layer 57.

If the nickel layer 56 is made to generate heat by passing electricity, the shape will change from linear (fig. 14 (1)) to curve (fig 14 (2)). In other words, bouncing action can be initiated.

When the current flow is stopped, it will return to the linear state in figure 14 (1). Thus it can be inferred that the response can be faster if the arm 48 is made smaller. A bimorph piezoelectric device can also be used as an arm. Some examples are given in figures 17 and 19. In these figures, multiple self propelled arms 59 are attached along the circumference with spaces between them, projecting diagonally from the surface of a bimorph piezoelectric device 58. The shapes are normally as shown in figure 17.

The arms 59 can be excited by repeating the bent state shown in figures 18 and 19. This action can be used to thrush forward or push back the capsule.

Thus, in the device for large intestines, exciting the arm 67 in capsule part 61 will push forward the capsule parts 61, 62 and 63. On the other hand, exciting the arm 68 in the last capsule part 63 will push backward the capsule parts 61, 62 and 63. Capsule part 61 can provide illumination while examination and the manipulator can be introduced through the aperture. Figure 20 shows the cutting of polyp 1 by using a snare wire 70. The test materials can be inserted to the capsule part 62 and stored. The data of the examined is processed by the telemetry function of capsule part 63. As the capsule 68 is attached, there is no need for a cable to collect the data.

Figure 21 is an example of invention no 7. It is used to examine the small intestine. It has two capsule parts, 72 and 73 which are connected. The main body 72 a in the capsule part 72 is attached

Figure 20 is example no. 6 of the invention. This is related to the micro robots used to examine large intestines. This device uses multiple capsule parts (61, 62, 63) and connects them in a line. The main body 61 a in the first capsule part 61 is fixed with lens 64 to examine the frontal view and the image picking device set in it takes the images. A window 65 for illumination and an aperture (not in diagram) are also made available around the lens 64. The role of the capsule 62 is to store the test materials, while the front end contains the aperture 66 that receives the test materials. The last capsule 63 has the telemetry function part.

The lower surface of the capsule 61 is fixed with arm 67 to push forward while the lower surface of the capsule 63 is fixed with arm 68 to push backward. Though both the arms 67 and 68 can be used in the same way as the other arms mentioned before, the set ups are in the opposite.

with lens 74 to examine the frontal view. An image picking device, not in the picture, is placed in it. A window 75 for illumination and an aperture (not in diagram) are also made available around the lens 74. The main body 73 a of capsule 73 has an ultrasonic device 76 placed around the circumference. It takes the ultrasonic images of the organs around it. The capsule part 73 also has an aperture for insertion and excretion of water. Both the capsule parts have telemetry functional part attached.

The lower surface of the capsule part 72 has multiple arms 78 for stoppage. The arm extends outwards and stops the capsule 72 at that position. The arms 78 can be used in the same way as mentioned above. The capsule 73 is attached with a balloon as reaches the wall of the small intestine 80 as it is raised.

In addition, the operating and observation information is processed by the aforementioned

telemetry function.

Figure 22 displays Embodiment 8 of this invention. This embodiment is a self-propelled capsule for tubule cavities as a medical micro robot. In other words, the self-propelled capsule 81 has a long flexible body and an objective lens 83a and illumination window 83a are located at its front end. In addition, self-propelling legs 84 as configured above, are located throughout the entire surrounding surface in multiple locations in the space before and after the surrounding surface of the long unit 82. The long body 82 can then be inserted into tubule cavities by operating the self-propelling legs 84. In addition, a flexible cable 86 is connected to the rear end of the self-propelled capsule 81. Illumination and image signals (or optical images) are transmitted through this cable 86.

Specifically, both robots 91 and 92 have a propulsion device 95 located on the capsule units 91a and 92a with a propulsion nozzle 93 and an attitude control nozzle 94. Furthermore, an illumination window 96 and an observation window 97 are situated on the capsule units 91a and 92a to internally observe the living subject. The observed information and the injection of the aforementioned various nozzles 93 and 94 are controlled by the commands from the external operating devices 98 and 99 outside the living subject using the telemetry function built into the various capsule units 91a and 92a.

An injection needle-shaped blood collection manipulator 101 is located at the tip of the blood collection robot 91 and a blood storage tank 102 and constituent separator 103 are situated within the

For example, when this is inserted into a biliary duct 87, the self-propelled capsule 81 is inserted through the channel 89 of the endoscope 88. By operating the self propulsion after inserting into the biliary duct 87, the device enters into the biliary duct 87 being self propelled.

Figure 23 to 26 display a micro robot that can be placed within a subject for extended periods to treat the living subject. Figure 23 displays two micro robots for living subjects, one is an example of a blood collection robot 91 and the other is a bone repair robot 92. The blood collection robot 91 collects the blood of a patient and has the function to analyze its components. The bone repair robot 92 synthesizes bones using the aforementioned components and has the function to repair the bones of the patient.

capsule unit 91a. The aforementioned propulsion device 95 and blood collection manipulator 101 are operated by wireless telemetry transmissions using an external operating device 98. The constituent separator 103 separates the blood into calcium, phosphates, oxygen, etc.

A bone resection manipulator 104, a bone binding manipulator 105, and an opening for artificial bones 106 are built into the bone repair robot 92. An artificial bone discharge device 108 configured from a bone synthesis device 107, pump, etc. is situated within the capsule unit 92a of the bone repair robot 92. The propulsion device 95 and bone binding manipulator 105 are operated by telemetry transmissions using an external operating device 99. The bone synthesis device 107 uses the elements from the aforementioned separation

and creates artificial bones using calcium phosphate material. The constituent separator 103 of the blood collection robot 91 and the bone synthesis device

Figure 24 is the block diagram of the aforementioned blood collection robot 91 and bone repair robot 92 system.

Therefore, the blood collection robot 91 and the bone repair robot 92 can be placed inside a living subject for extended periods, as displayed in Figure 23. The blood collection robot 91 can collect and store blood from the blood vessels 100 of patients and separate components from the blood that are necessary to synthesize bone. This material can then be transported to the bone synthesis device 107 of the bone repair robot 92 and artificial bones required for repair can be synthesized. In addition, the bone repair robot 92 eliminates the lesions of the patient's bones 110 by using the bone resection manipulator 104 and repairs are conducted using the artificial bones received from the artificial bone discharge device 108 by the bone binding

107 of the bone repair robot 92 are linked by a material transport pipe.

manipulator 105.

The mobility of the aforementioned robots 91 and 92 are configured to receive their operating power from within the living subject. An example of this procedure is displayed in Figure 25. In other words, the constituent separator 111 of the blood collection robot 91 isolates glucose ($C_6H_{12}O_6$) and oxygen (O_2) from the collected blood and stores the components in their respective storage tanks 112 and 113. When energy is required, electrical energy is extracted by oxidizing the components using the oxidative dissolution device 114. This electrical energy can, for example, be used to drive the motor 115 or operate the propulsion device 116. As an energy source is available within the living subject, external power supply becomes unnecessary and the robot can be placed within living subjects for extended periods.

In addition, the source of power from the living subject may also be internal combustion. Figure 26 displays an example of this method. In other words, install the device with a constituent separator 121 that separates oxygen from the blood and an oxygen storage tank 122 that stores oxygen. In addition, install the device with a constituent separator 123 that separates methane gas from stool and a methane gas storage tank 124 that stores methane gas. The oxygen and methane gas can be ignited to operate the device using internal combustion 125. When energy is necessary, thermal energy can be extracted by oxidizing the methane gas using internal combustion 125. This, for example, drives the propulsion device 126.

Although the aforementioned example was of bone repair, the device can also be similarly used to repair blood vessels. Figure 27 displays the blood vessel repair robot 130. The blood collection robot 131 operates in the same manner as explained above.

An artificial sheet 132 grasping and handling manipulator 133, suture needle manipulator 134, discharge opening 136 supplying protein thread 135, artificial sheet (protein film) 132 discharge opening 137, etc. are built into the capsule unit 130a of the blood vessel repair robot 130. In addition, an illumination window 136 and an observation window 139 are situated on the capsule. A propulsion device with a propulsion nozzle 141 and an attitude control nozzle 142 are built into the capsule unit

130a.

Furthermore, as displayed in Figure 28, the protein film synthesis device 145 that synthesizes protein films using the components received through the transportation pipe 143 from the blood collection

The constituent separator 149 of the blood collection robot 131 isolates the proteins from the collected blood. The blood vessel repair robot 130 receives the transported proteins and synthesizes artificial sheets 132 of protein film and protein thread 135 and delivers them as required using the pumps 146 and 148. This operation is controlled by wireless telemetry transmissions.

The blood vessel repair robot 130 repairs blood vessels 150, for example, by sewing artificial sheets 132 on aneurysms using the handling manipulator 133 and suture needle manipulator 134. The consumable materials, artificial sheets 132 and protein thread 135, are produced within the living subject making external supplies unnecessary. Accordingly, the device can function within living subjects for extended periods. The source of energy is also as explained above.

In addition, a receiver 155 for telemetry transmissions and a drive circuit 156 for the propulsion method 154 are built into the various micro robots 151, 152, and 153.

Furthermore, an illumination method 157 using LED's, observation method 160 using an objective lens 158 or image pickup device 159, transmitter 161, and guidance device 162 are built into the first micro robot 151. Image signals that have been converted by the image pickup device 159 transmit the signals to an external receiver from a transmitter 161. In addition, the following guidance device 162 transmits emitted electro-magnetic waves and guidance signals to micro robots 152 and 153.

A storage space 164 that stores the manipulator

robot 131, pump 146 that discharges protein films, protein thread synthesis device 147 that synthesizes protein thread, and pump 147 that discharges protein thread are built into the capsule unit 130a.

Figures 29 to 31 display medical in-vivo robots using other systems. In other words, these medical in-vivo robots are made up of multiple micro robots components 151, 152, and 153 that have been separated. The aforementioned propulsion method 154 has been configured to the external side of the various micro robots 151, 152, and 153 and the device independently propels itself within the ducts by using this propulsion method 154. For example, the propulsion method 154 of this device has situated bristles diagonally on piezoelectric devices located in external rings around the micro robots.

The device moves forward or backwards according to the vibrating patterns of the piezoelectric devices. In addition, the aforementioned propulsion method may also be used.

163 to process living subjects, drive motor 165 that operates the manipulator 163, and a cover 168 to cover the opening of the storage space 164 are built into the second micro robot 152. The power source 169 is built into the third micro robot 153. Furthermore, these micro robots 151, 152, and 153 move around the body independently after receiving wireless signals from external control methods, however, the devices can be linked and integrated (combined), as displayed in Figure 30. This allows for the exchange of energy and signals.

Figure 31 displays a specific example. An electromagnet 171 is divided into three, set diagonally on each of the surfaces of the joint ends, and the polarity of each magnet is reversed.

Accordingly, there is no slippage when docking. An electric signal transmission connector 172, LED 173, and power source connector 174 protrude out

The electric signal transmission connector 172 is connected to the drive circuit. The power source connector 174 is connected to the power source. A light-sensitive element 178 is built into the female connector 176. Accurately determine the angle by matching the axis line when the guidance signal at the front of the micro robots 151 and 152 is in close range of the micro robots 152 and 153 using the LED 173 and light-sensitive element 178. The micro robots 151, 152, and 153 reach the opening of the target body cavity 183, i.e. biliary duct, through the channel 182 of the endoscope 181.

The first micro robot 151 is sent to the target body cavity 183 by remote control. Turning on self-propulsion moves the device forward. Once a

from the joint end surface at the front and corresponding female connectors 175, 176, and 177 are located on the joint end surface at the rear.

diagnosis is conducted on the affected area, the next micro robot 152 suited for treatment is sent. If it looks like treatment will take some time, micro robot 153 with a large capacity power source can be sent.

Furthermore, Figures 32 and 33 display other formats of the micro robot. The micro robot indicated in Figure 32 is configured with an ultrasonic transducer 194 and drive motor 195 that is used for observations and propulsion. As displayed in Figure 33, the micro robot 196 comes with an injection needle 197 and is linked to the micro robot 198, which comes with a drug solution tank 199.

[Effect of the Invention]

As explained above, the endoscope of this invention is suited for use in low-gravity and zero-gravity spaces; it simplifies examinations, reduces invasiveness, and can be used for a broad range of examinations.

4. Brief Description of the Drawings

Figures 1 to 3 display Embodiment 1 of this invention. Figure 1 is the schematic perspective view of the endoscope, Figure 2 is the block diagram of the configuration, and Figure 3 is the drive time chart. Figure 4 displays Embodiment 2 and is the schematic perspective view of the endoscope and Figure 5 is the block diagram of the configuration. Figure 6 displays Embodiment 3 and is the schematic perspective view of the endoscope and Figure 7 is the block diagram of the configuration. Figure 8 displays Embodiment 4 and is the schematic perspective view of the

endoscope and Figure 9 is the block diagram of the configuration. Figures 10 to 13 display Embodiment 5 of this invention. Figure 10 is the side view while in use, Figure 11 is the explanatory diagram while operating, Figure 12 is the top view while operating, and Figure 13 is the cross-section view while operating. Figures 14 to 16 display variations of the example while operating. Figure 14 is the perspective view while operating, Figure 15 is the top view while operating, and Figure 16 is the cross-section view while operating. Figures 17 to 19 display the cross-section view while operating in other methods. Figure 20 is the schematic perspective view during the use of another example. Figure 21 is the schematic perspective view during the use of a further example. Figure 22 is the schematic perspective view during the use of a further example. Figure 23 is the perspective view of a medical micro robot and Figures 24 and 25 are

block diagrams of the configuration. Figure 26 is the block diagram of a variation of the example. Figure 27 is the perspective view of a medical micro robot and Figure 28 is the block diagram of the configuration. Figures 29 and 30 are the perspective views of other medical micro robots and Figure 31 is the perspective view expanding the end section. Figures 32 and 33 are the perspective

views of other variations of the robot example.

1: Main Unit; 2: Objective Lens; 11: LED; 12: Nozzle; 14: Tank; 15: Receiver; 21: Piezoelectric Device; 25: Fan; 26: Motor; 38: Nozzle.

Applicant Representative:

Patent Attorney Jun Tsuboi

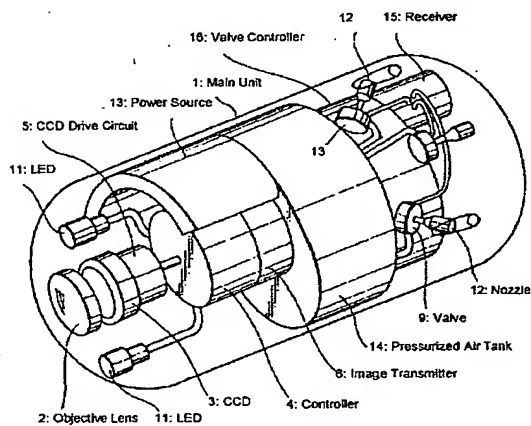


Figure 1

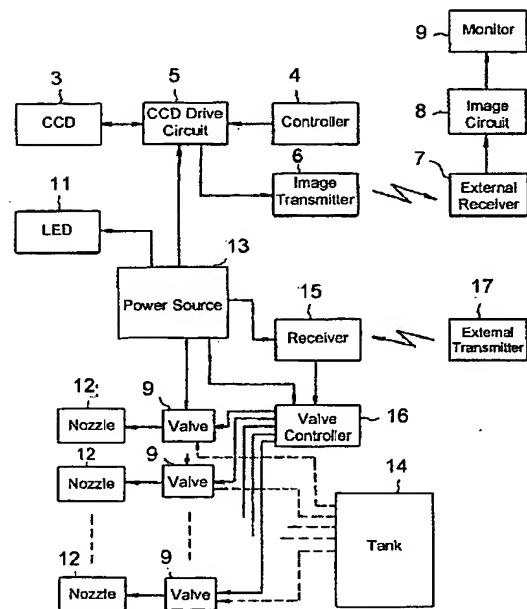


Figure 2

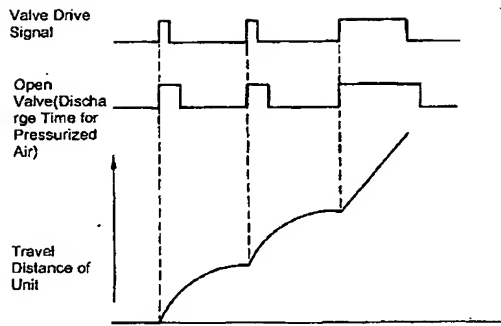


Figure 3

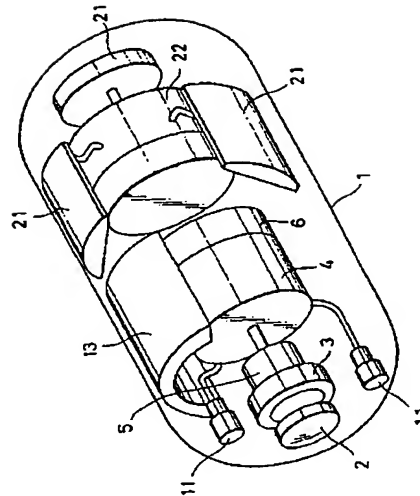


Figure 4

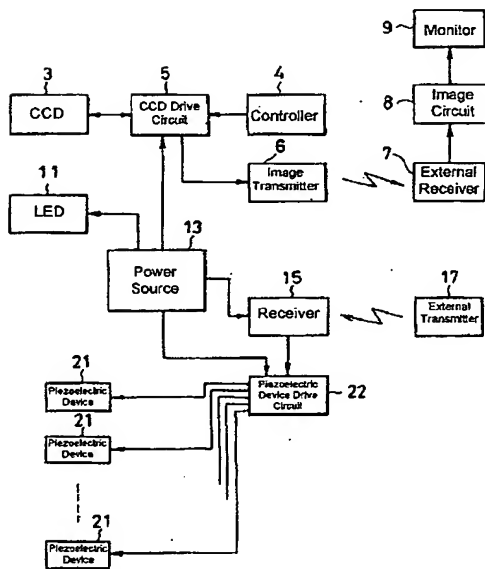


Figure 5

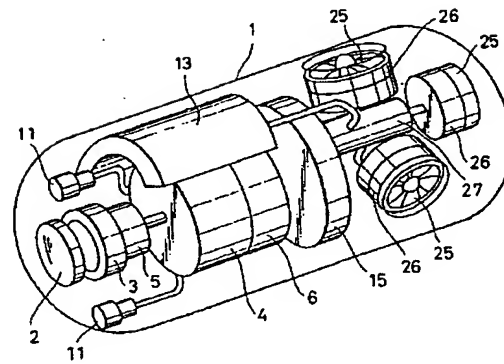


Figure 6

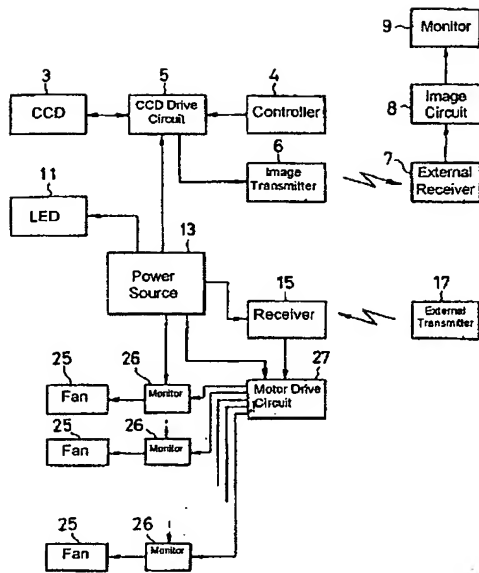


Figure 7

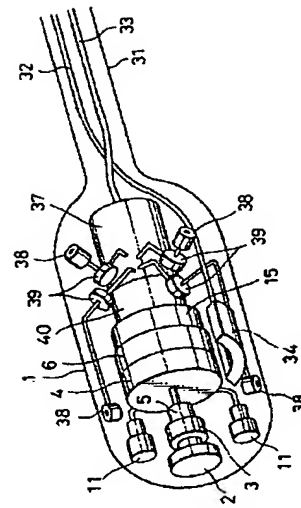


Figure 8

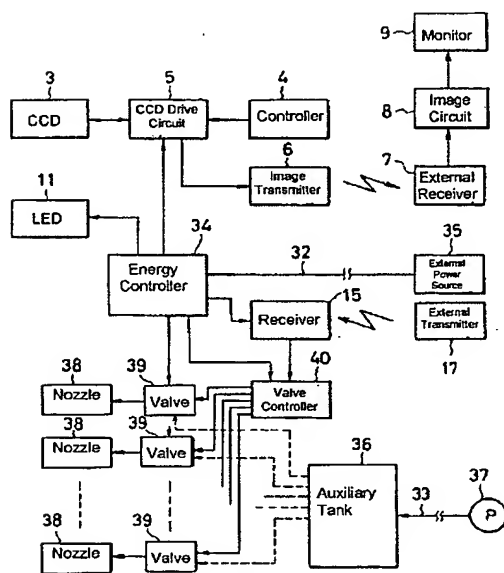


Figure 9

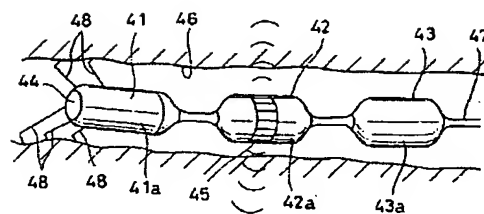


Figure 10

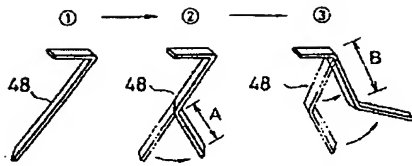


Figure 11

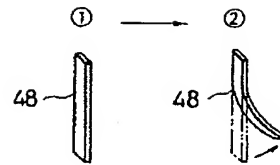


Figure 14

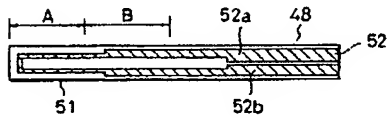


Figure 12

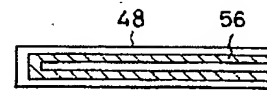


Figure 15

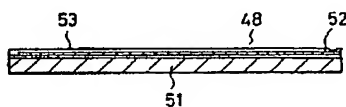


Figure 13

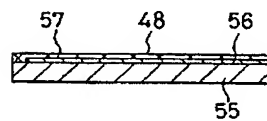


Figure 16

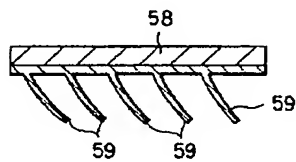


Figure 17

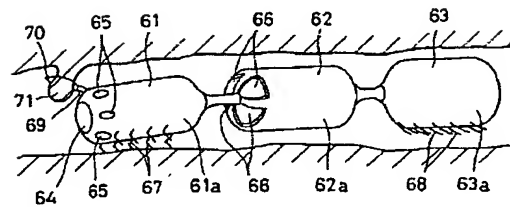


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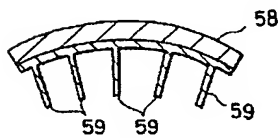


Figure 18

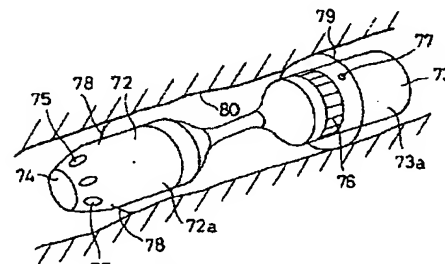


Figure 21

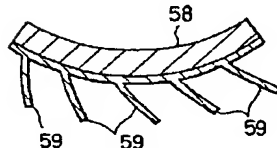


Figure 19

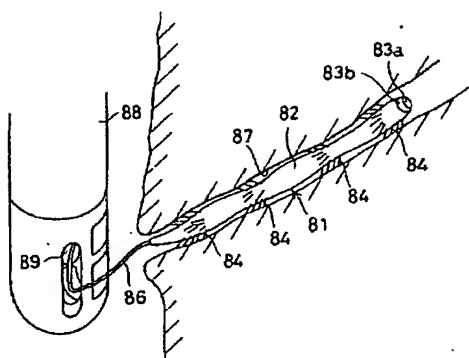


Figure 22

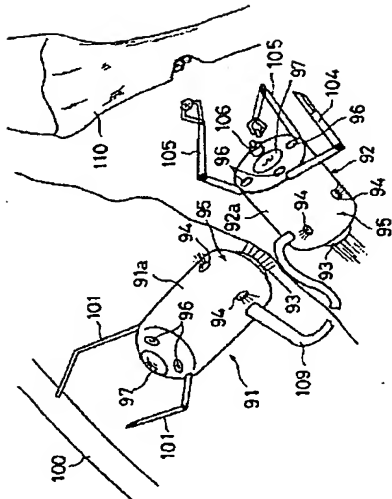


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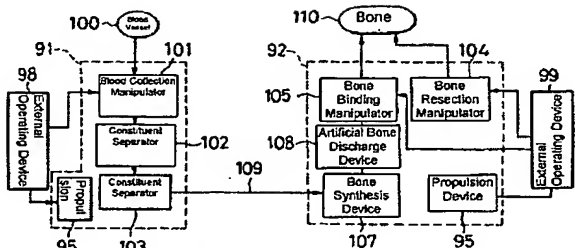


Figure 24

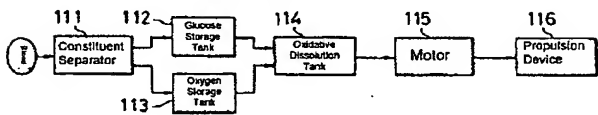


Figure 25

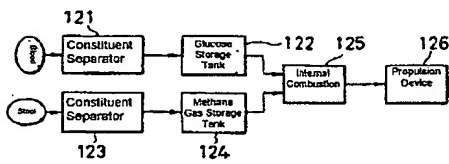


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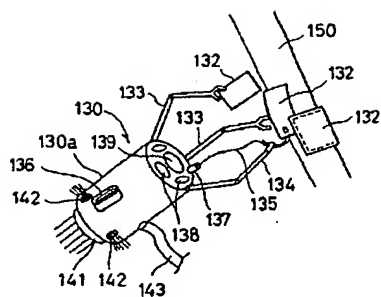


Figure 27

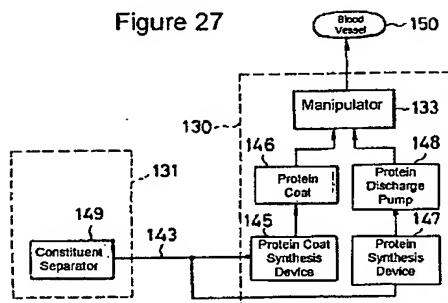


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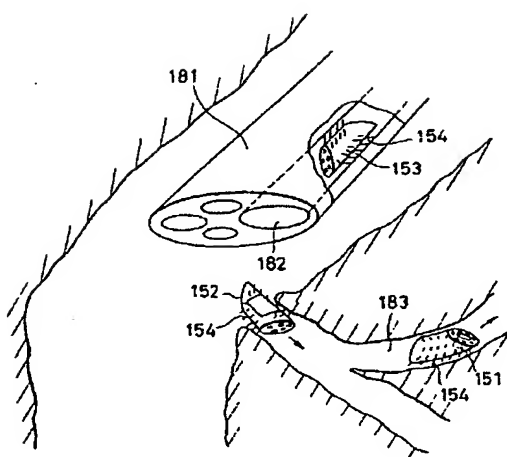


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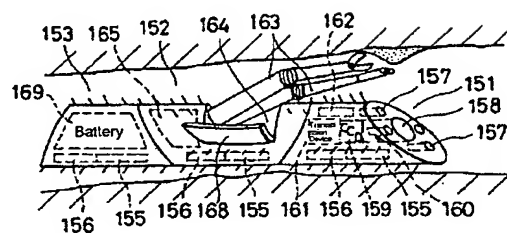


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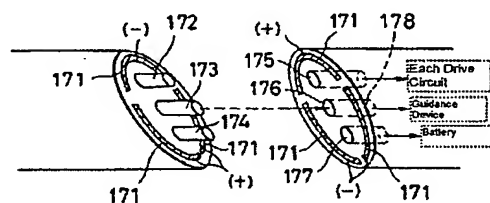


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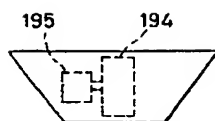


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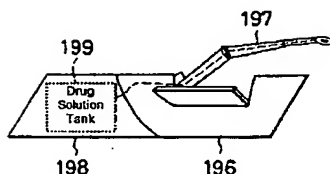


Figure 33

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